USES OF THE ROENTGEN RAYS IN THE STUDIES OF NORMAL AND PATHOLOGICAL ANATOMY OF THE INTERNAL STRUCTURES OF THE FACE.

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The closer the surgical anatomy of the face is studied by either the old stereotyped methods or the modern plan of sectionizing the parts in various directions, the more considerably it will be found to vary. The internal anatomy is not alike in two individuals; further than that, the two sides of the same individual are not alike. This condition often makes a true diagnosis and proper treatment most difficult. By the use of the Roentgen rays, by either the ordinary or the stereoscopical radiograms, much can be learned, both as to normal and pathological conditions.

The following illustrations will demonstrate the usefulness of radiograms:

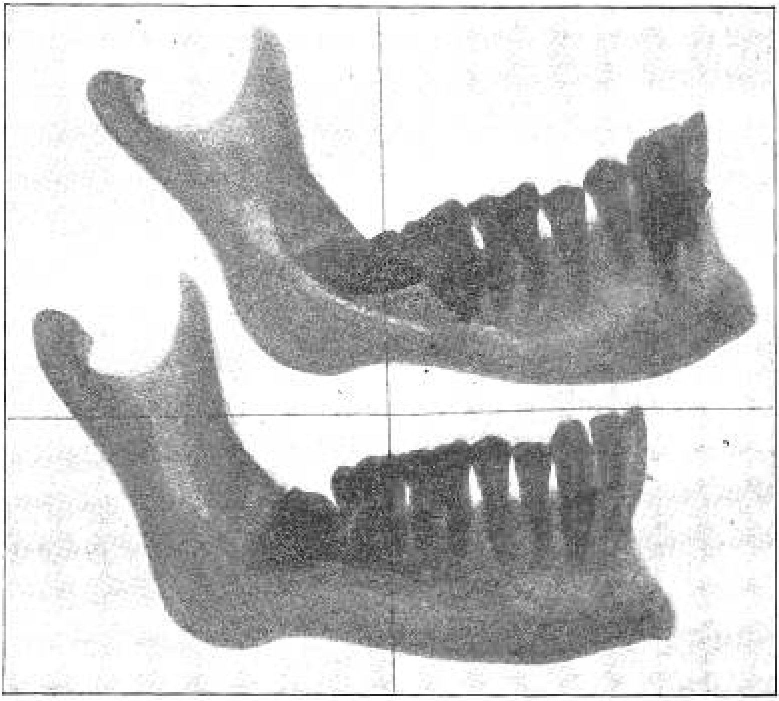
Fig. 1 is made from one-half of a steroscopical radiogram showing the general outline of the bone of two halves of the same cleaned dried mandible. Variations in the density of the cancellated tissue situated between the cortical portions of the bone are seen; also in the position and shape of the roots of the teeth with their nerve canals. The inferior dental canal can be plainly seen extending from the inferior dental foramen nearly to the apex of the canine tooth. In the upper picture an impacted lower third molar is visible, showing a pathological condition of the roots and those of the adjoining second molar; the roots of the impacted tooth pass backward just above the inferior dental canal, while in the lower picture the roots pass downward to the inner side of the canal. When the roots are in these positions they are liable to cause such pathological conditions as are exhibited in exostosis, both of roots and contiguous bone, and are also sources of other disturbances, such as neuralgia.

When the above picture is shown with its stereoscopical mate at normal size by reflecting stereoscope, the anatomical structure, with their positions, can be better studied.

During a visit to Dublin in the summer of 1903 the writer had the pleasure of seeing some stereoscopical radiograms made by Dr. William S. Haughton, to whose kindness he is indebted for the four illustrations which follow.

Fig. 2 is a stereoscopical radiogram of a cleaned or dried skull. The skull stands out in bold relief, the teeth and their pulp cavities and their relative positions as they are held in the alveolar process being clearly indicated. The upper third molars are impacted and rest on a line with the roof of the mouth near their place of development. There is also an impacted upper premolar resting above the second premolar. In an ordinary x-ray picture it would be impossible to localize the true position of these teeth or of any foreign body, such as a bullet, etc., but with a stereoscopical picture they could be located. The region of the maxillary sinus is beautifully shown with a greater portion of the wall of the sinus. The floor of the boundaries of the orbit, its external wall, and the frontal sinuses, can be seen. Commencing with the right external angular process, the boundaries of the temporal fossa are all very well marked.

FIG. 1.

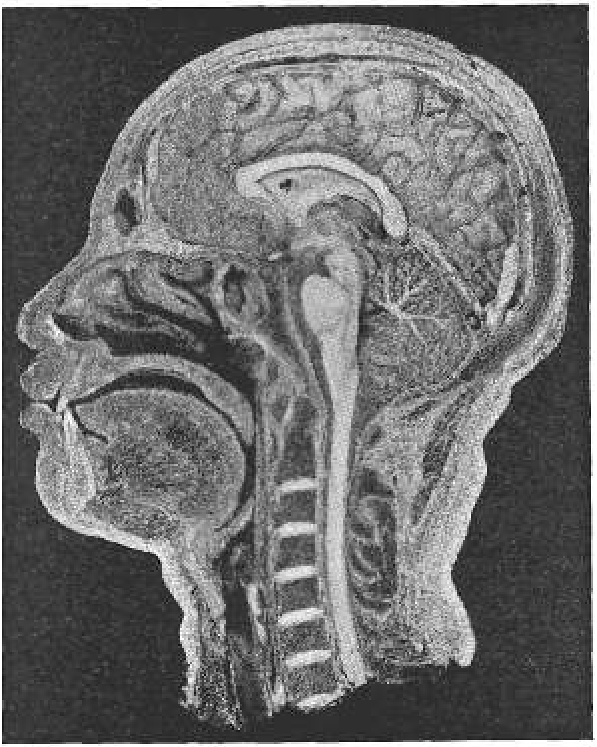


One-half of stereoscopical radiogram.

Fig. 3 is from the same stereoscopical radiogram as Fig. 2, the only difference being that the two halves of the stereogram have been changed in position. In Fig. 2 one is looking at the skull with the crossed wires in front of it, while in Fig. 3 the wires are beyond it. The latter view allows of a better study of the internal portion of the skull. The boundaries of the fossæ of the brain-case are well shown, and the free edges of the lesser wing of the sphenoid bone and the petrous portion of the temporal bone are markedly brought out. In looking through the skull to the opposite side of the brain-case, the sutures are seen; also the grooves for the meningeal arteries. Above the body of the sphenoid the sella turcica is seen, and the sphenoidal sinuses are also shown in the body of the bone with the posterior ethmoidal cell in front of them. Within the petrous portion of the temporal bone the internal auditory meatus shows plainly, and back of the petrous portion is the deep groove for the lateral sinus.

Fig. 4 is a stereoscopical radiogram also by Dr. Haughton. It is a vertical picture taken through the skull shown in Figs. 2 and 3.

FIG. 6.

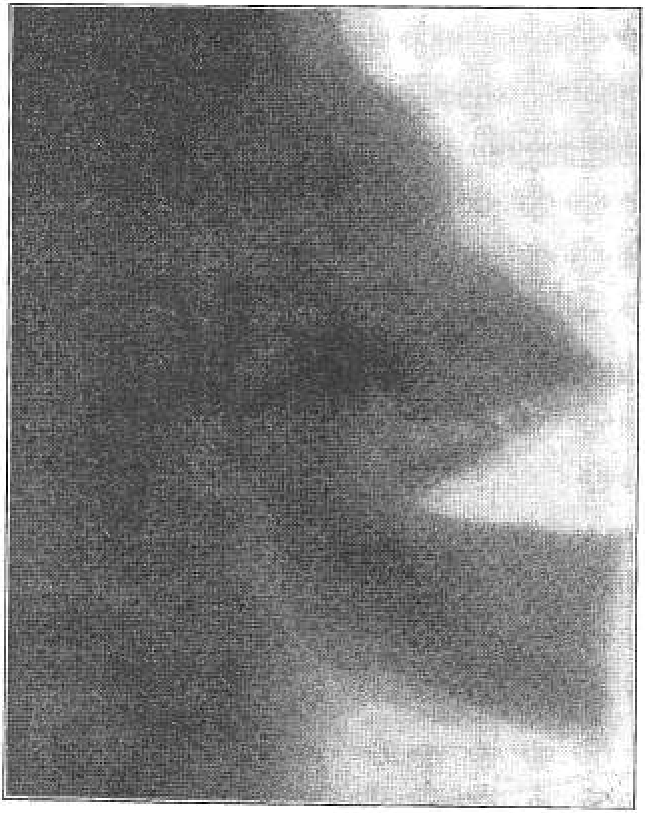


Sagittal section of a frozen head, showing the relation of the tissue at the base of tongue.

It gives a view of the base of the skull, the teeth, and the roof of the mouth. The position of the impacted teeth is well defined. Along the centre of the roof of the mouth are two lines showing the two plates forming the vomer and the other portions of the septum of the nose. The septum is straight, with a slight spur on the left side. The turbinated bones are seen through the roof of the mouth. Looking through the bone at the base of the malar bone and through the tissues surrounding the teeth, the maxillary sinuses can be well defined. In passing back of the facial bones the internal structure of the basilar process of the occipital bone, and the petrous portion of the temporal bone can be studied.

• Fig. 5 is from the same radiogram as Fig. 4, with the position of the two halves of the stereoscopical pictures changed from left to right and right to left. This gives a view of the skull from the top downward through the skull and out through the base, the exact opposite of that seen in Fig. 4. It shows the floor of the three fossæ of the brain-case. The floor of the anterior fossa is somewhat indistinct, on account of its thinness, which allowed the x-ray to pass through it, but in so doing it reveals the ethmoid cells and the sphenoidal sinuses. Posterior to this position and extending out

FIG. 7.

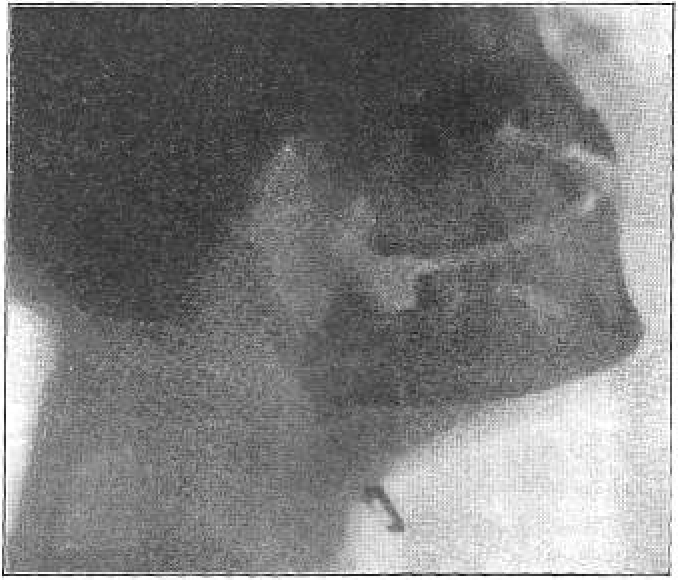


Radiogram, taken by Dr. Kassabian, of a living subject, showing the position of the eminentia articularis to the head of the condyle, when the mouth is wide open.

laterally, the free margin of the lesser wings of the sphenoid are seen; also the middle fossa of the brain-case. The petrous portion of the temporal bone is well defined, with the various depressions along its ridge and two of its surfaces. Looking down into it the various cells and passageways are plainly visible. The mastoid cells are also shown.[1]

Much could be written about these four stereoscopical pictures, but enough has been given to indicate the many points of interest which can be studied without cutting the skull into sections. When penetrating rays of sufficient strength are used, similar features can be brought out in the living subject.

FIG. 8.



Radiogram taken by Dr. Pfahler, showing an impacted lower third molar, with an inflammatory condition in the surrounding tissue.

THE MOVEMENT OF THE MANDIBLE. The general idea is that the mandible moves on a pivotal point within the glenoid cavity. From the study of the x-ray pictures of this bone taken from the living subject with the teeth in normal occlusion, with the mouth wide open, and in various positions between these points, it has been determined that the head of the condyle changes from one position to another. When the teeth are in occlusion, or nearly so, the condyle rested in the anterior portion of the glenoid fossa, as seen in Fig. 8.

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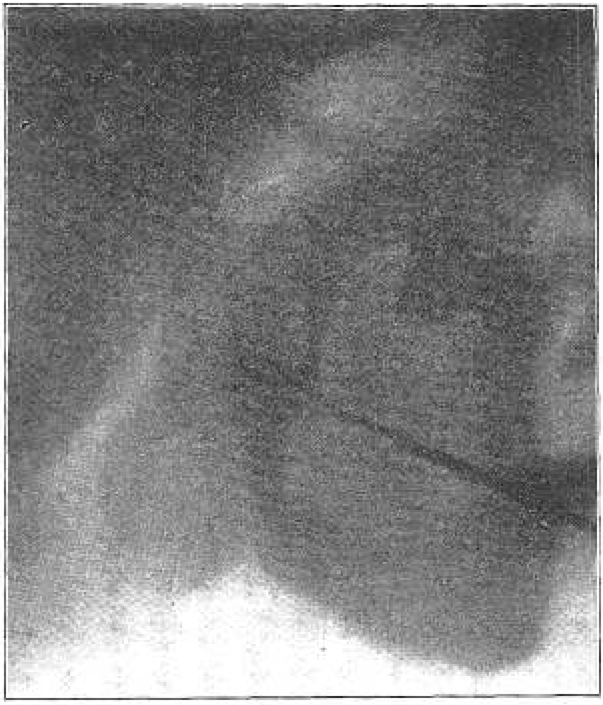
[1] The original four pictures as given to the writer by Dr. Haughton are little above the normal size, and when viewed in pairs by the use of a large reflecting stereoscope they show to a much better advantage than when reduced, to be used by the small prism stereoscope, as illustrated in this paper.

When the mouth was slightly opened the condyle seemed to be lowered a trifle and resting against the articular eminence. When the mouth was forced wide open the condyle was immediately under and resting against the eminentia articularis. In a few cases it was found slightly in advance of the eminence. In all cases examined, where the mouth was only slightly opened, the angle of the jaw moved slightly downward and backward.

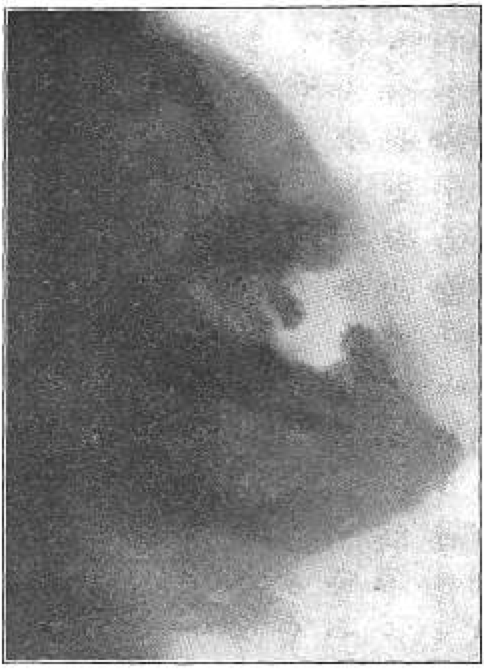
FIG. 9.



Radiogram by Dr. Kassabian, showing necrotic condition of the ramus.

If the mechanism of the anatomy of the articulation of the lower jaw be carefully examined, it will be found that the internal, external, and stylomandibular ligaments act as suspensories to the jaw and have a tendency to fix its angle when it is carried slightly downward and backward, as when the mouth is partially opened. The muscular fibres of the internal pterygoid and the external portion of the masseter muscles have the same tendency. The condyloid process of the mandible acts as the fulcrum or pivotal point of the bone. The point, or fulcrum, mainly, through the action of the external pterygoid, moves forward with its cushion, the interarticulating fibrocartilage. While the jaw is being carried forward the mouth can be opened slightly, still retaining the fulcrum, or pivotal point at the end of the condyle, but as the mouth is opened wider, the fulcrum is gradually changed from the condyle toward the more central portion of the ramus and then toward the gonion, the angle probably eventually becoming the fulcral point through the partial fixation of the ligaments and muscles before referred to. By the action of the external pterygoid muscle, the condyle is drawn forward, and the mouth is thrown wide open, with the condyle under or slightly in advance of the ementia articularis, as shown in radiograms taken when the mouth is wide open. It is thus that the external pterygoid becomes an opener of the mouth. The reason for the change of fulcrum, or pivotal point, may be found in the condition which is obtained in the pharyngeal region. If in opening the mouth wide the head of the condyle acted within the glenoid fossa as the only pivotal point, the lower portion of the ramus with the body of the bone, the hyoid bone, the base of the tongue, and other associated tissues would be carried backward until the soft tissue

FIG. 10.



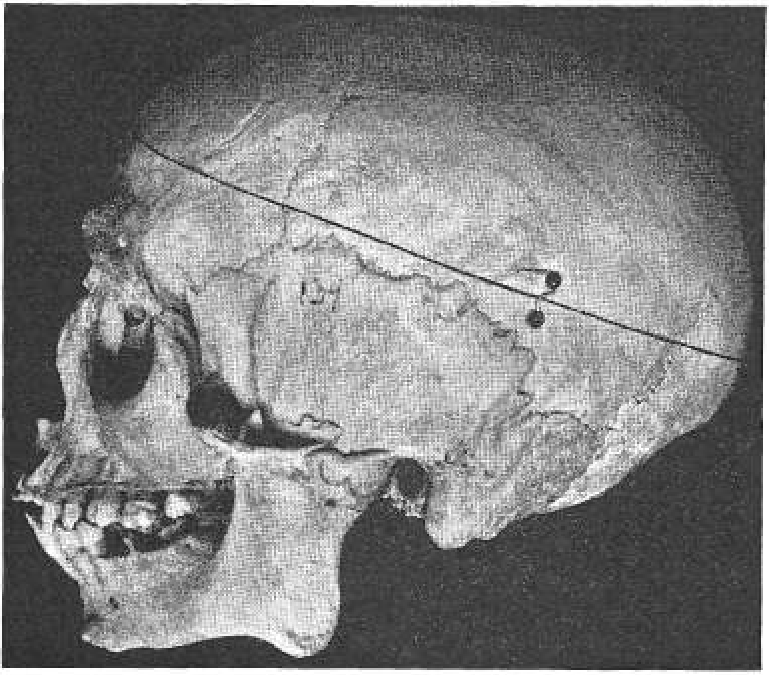
Radiogram.

coming against the post-pharyngeal wall would interfere with the functions of that region. By the transfer of the point, this possibility is avoided.

Fig. 6 is made from a frozen section of a normal head, an examination of which shows the close relation of the posterior portion of the tongue and its associated tissues with the post-pharyngeal wall.

Fig. 7 was made from an *x*-ray taken while the mouth was wide open. It shows that the condyle has been carried well forward, with its upper surface resting immediately under the eminentia articularis. This illustration shows other interesting points. The distal border of the ramus is anterior to the line of the vertebra, which is the normal position, even when the mouth is wide open. This point will be referred to again.

FIG. 11.

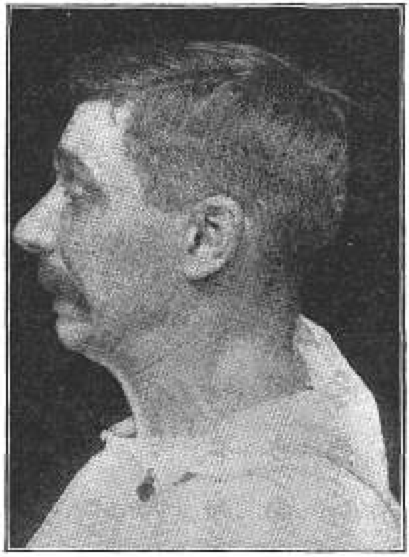


True ankylosis of temporomandibular articulation.

PATHOLOGICAL CONDITIONS. Fig. 8 is made from a patient of Dr. Dray, of Philadelphia, to whom the writer is indebted for this illustration. In the lower jaw the distal root of the second molar is covered by the crown of an impacted third molar. A cloudiness in this region indicates a condensation process, probably inflammatory, which exists not only in the bone, but in the surrounding tissue. This is of vital surgical importance, as the patient was suffering from neuralgia at the time the picture was taken, and gave strong clinical evidence of the inflammatory condition in this region, which was caused by the impacted lower third molar resting against the distal root of the second molar. The absorption of the tissue of the root of the second proceeded until the pulp was exposed, thus causing the inflammatory condition noted. Upon the second molar being extracted, the inflammation and neuralgia subsided.

Fig. 9, taken June 25, 1904, shows a radiogram of the lower portion of the face. The ramus of the jaw was in a necrotic condition. A steel probe could be passed into it at almost any portion. At the time the picture was taken, the probe was passed into the bone just below the coronoid process well through toward the temporomandibular articulation. The radiogram shows the probe in position, and also that the lower portion of the ramus was so decalcified that the *x*-ray passed through it (indicated by the light area). This picture was an important factor in making the true diagnosis of the condition.

FIG. 12.

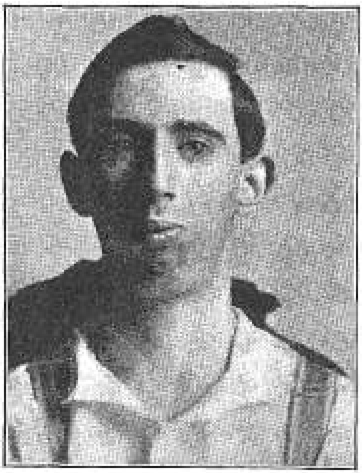


The action of the superficial depressor muscles of the mandible in ankylosis.

Fig. 10 is another radiogram of the same patient taken on November 19, 1904. It shows that the light area of Fig. 9 has become more dense or regenerated, except a portion of the angle, which corresponds to the clinical examination. The balance of the bone has become so dense that a sharp steel probe cannot be passed into it, as was done when the first picture was taken.

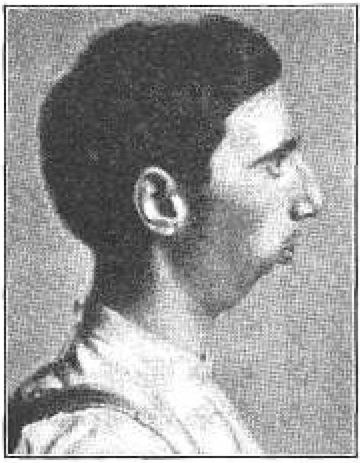
TYPICAL SHAPE OF THE MANDIBLE AFTER A PERIOD OF ANKYLOSIS. In 1898 the writer drew the attention of the profession to the fact that "the normal application of force to the developing bone results in the development of the form of the bone. The abnormal application of forces under the same circumstances results in the development of an abnormal form. Abnormal application of forces to bone in adult life will also change and modify its shape and character. The bones becoming changed, the whole body is modified according to the change in the tissue." The modification of bone by abnormal muscular action is well illustrated by the changes found in persons suffering from true or false ankylosis of the temporomandibular articulation.

FIG 13.



Front view of a typical face of a person with an ankylosed jaw.

FIG. 14.



Profile view of a typical face of a person with an ankylosed jaw.

In a paper written in 1898, Fig. 11 was used to illustrate the usual changes brought about in the lower jaw through the influence of ankylosis. In the same paper Fig. 12 was used to illustrate the action of the muscles drawing upon the bone in an endeavor to open the mouth. The person from whom Fig. 12 was made had been suffering from false ankylosis for about fifteen years.

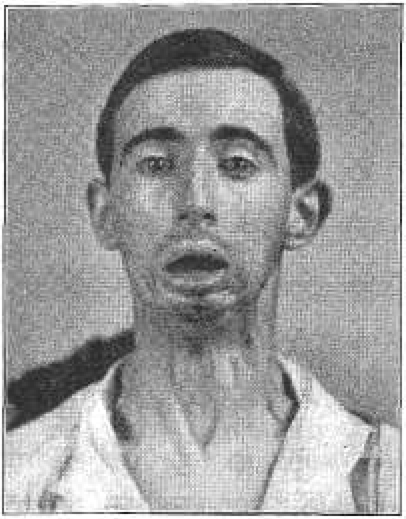
Such changes in the form of the bone have been observed from time to time in various patients. Within the last few months a very interesting case has come under the writer's observation for consultation, which Figs. 13, 14, 15 and 16 well illustrate.

Fig. 13 gives a front view of the face, showing a heavy fold of tissue under the jaw, which would have been normal if the jaw were fully developed and in its normal place.

Fig. 14 is a profile, showing the recession of the mental process; also the "bagging" of the soft tissue, and below this are the mylohyoid muscles extending down to the hyoid bone, which has become displaced downward and backward.

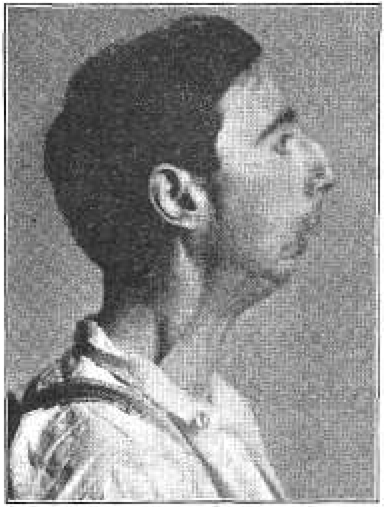
Fig. 15 is another front view made when the patient was endeavoring to open the mouth. The lower lip and muscles are pulled down principally by the platysma myoides. The sternocleidomastoid muscles are well shown, also the sternohyoid.

FIG. 15.



Front view of a person with an ankylosed jaw when endeavoring to open the mouth.

FIG. 16.

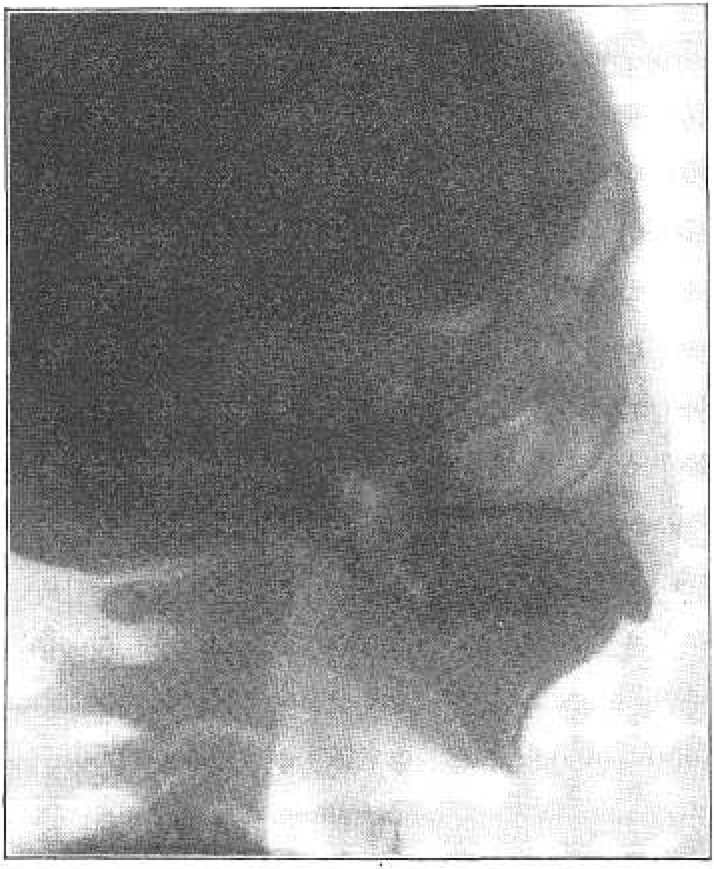


Profile view of a person with an ankylosed jaw endeavoring to open the mouth.

Fig. 16 is a side view, showing the side muscles in action. The platysma myoides and the omohyoid are well shown; a continuous line extends from the omohyoid to the jaw. This continuation in reality is the anterior belly of the digastric muscle. The action of these muscles can be studied from these last two pictures. Naturally, the anatomist and surgeon would be anxious to know something about the changes that have taken place in the internal anatomy through the muscular action. With this idea in view, two *x*-ray pictures were made, one from each side.

Fig. 17 is from a radiogram made from the right side, and shows that the mandible has changed completely, taking on the character of a typical ankylosed jaw (see Fig. 11), as was shown some eight years ago, when the writer gave several illustrations demonstrating this point. This and other cases have confirmed the description and cause then given. The mental process is drawn back and the gonion downward. In this case the ramus is drawn back beyond a line parallel with the anterior portion of the vertebra. This may be partly due to the removal of the condyloid process in a surgical operation. Through the loss of this process and with the action of the external pterygoid muscle, there is a tendency for the lower jaw to be forced backward; should it go back, the hyoid bone, the tongue, and all the tissues associated with it, must move backward nearly to or against the post-pharyngeal wall. All that prevents this tendency is the resistance exerted by the internal pterygoid muscles and

FIG. 17.



Radiogram of a living subject, showing the typical slope of an ankylosed jaw.

the external portion of the masseter. When the condyles have been removed and the external pterygoids severed from their insertions, the internal pterygoids and parts of the masseter have a certain amount of power to draw the jaw forward; also to rock it from side to side.

There are many other points of great anatomical interest in this picture. For instance, the dark line above the teeth is the roof of the mouth taken edgewise, which makes it look dense. Above this dark line are the maxillary sinuses. The line over this is in part the floor of the orbits, still above which is the region of the ethmoid cells. The roof of the orbits is outlined, and above that again the frontal sinuses are clearly seen, showing a septum between them. It would not do to claim that there was no septum, from this picture alone, as it is possible that it is there, and being thin, the rays have passed through it. Until lately the writer was of the opinion that there was always a complete septum between two frontal sinuses, but he has now in his possession two specimens without complete septa. If this person were suffering from disturbances in the frontal region, a radiogram, similar to this, might demonstrate the trouble. If the lower portion of the sinus should be filled with pus, it would be indicated by a darker shade than the upper. To prove that this dark portion contained fluid, it would be necessary to take another radiogram with the head at a right angle to the first position. Gravitation of pus would then change the position of the dark line, thus demonstrating the fluid nature of the contents.

If a stereoscopical picture had been taken of this subject and each half had been as good as the one shown, they would have proved of more value.

Radiographical pictures of dried skulls when shown by the stereoscope are all that can be asked for. But the surgeon will not be satisfied until the radiographer produces as good pictures from the living subject as those from the dried skulls. Sectionizing and the stereoscopical pictures have proved that no two skulls are alike in regard to the roots of the teeth, their shape, or position. The pneumatic sinuses and cells also differ greatly, therefore, when trouble exists in these regions and the surgeon is about to operate, he is anxious to know the special anatomy of the part to be operated upon, as to make a correct diagnosis is impossible without these. In such times the value of the *x*-ray is inestimable if the radiogram can be so perfected as to show density, shape, size, etc., in all their relations in a living subject. The writer is of the opinion that this knowledge will be obtained through the use of the stereoscopical radiogram. Those who are investigating along this line of work have accomplished a great deal during the past eight years since the discovery of the penetrating powers of the *x*-ray, and it is improbable that they have reached the limit.